



Variations of tropical deep convective clouds on rainfall and SST

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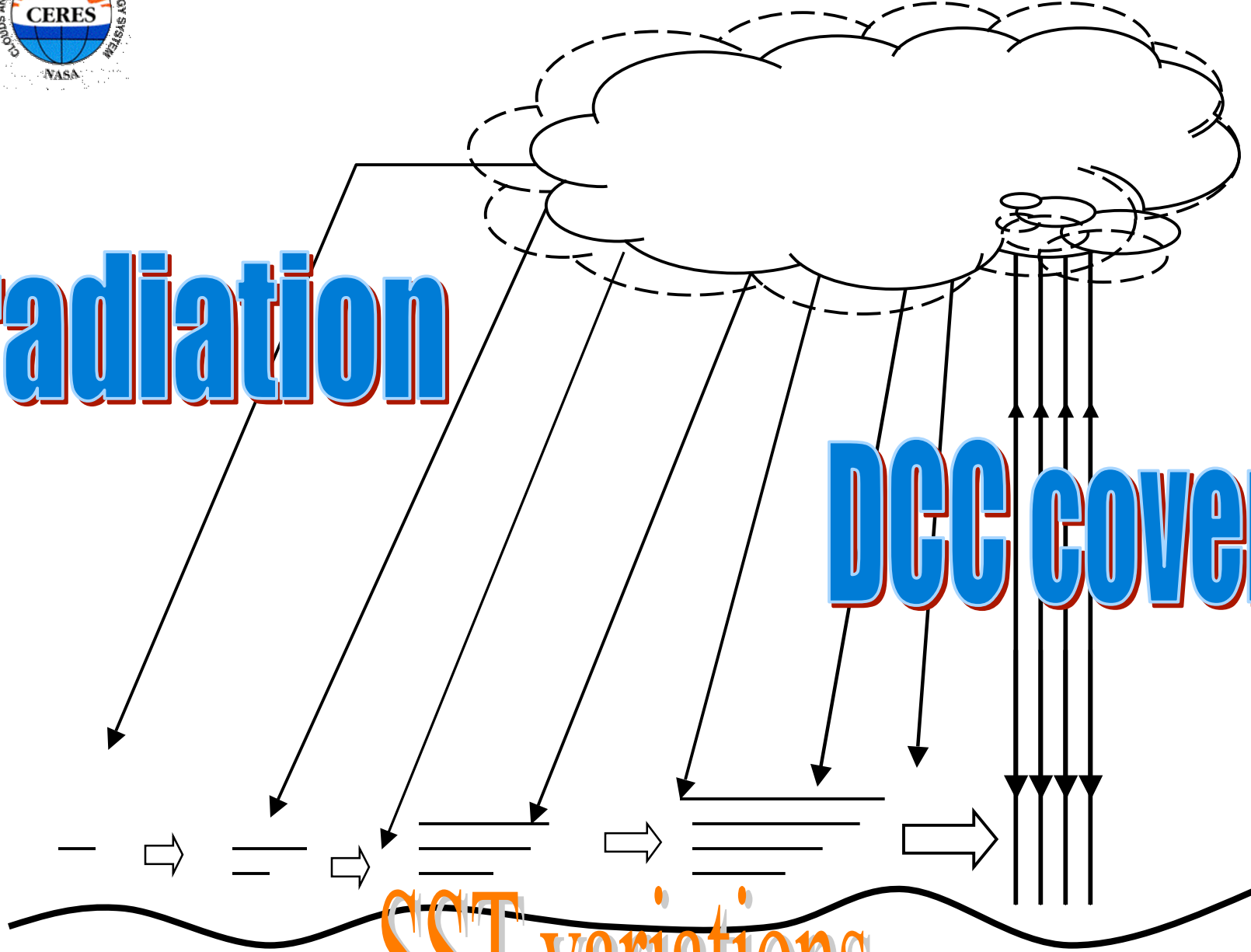
Simplified Tropical Convection



radiation

DCC coverage

SST variations





Background



1. Background

deep convective clouds vs SST:

Lindzen et al. (2001);

Lin et al. (2002) & Chamber et al. (2002) -- radiation

Hartmann & Michelsen (2002) – same data

Del Genio & Kovari (2002) -- storms from TRMM

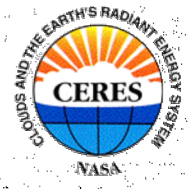
Lin et al. (2004) – decadal ERBS data

constant anvil temperature

hypothesis by Hartmann

focus here: coverage of DCC clusters with rainfall & SST

albedo, LW & SW radiation



analysis method



1 . Matching CERES, VIRS, & TRMM rainfall data (TMI & PR)

CERES project: CERES + VIRS \Rightarrow CERES clouds

here: TMI + CERES clouds + rainfall data

2. Statistics

199801 ~ 199808 TRMM

3. Cloud classification

cold clouds: $T_b(11\mu\text{m}) < 273\text{K}$ storms: rainfall cells

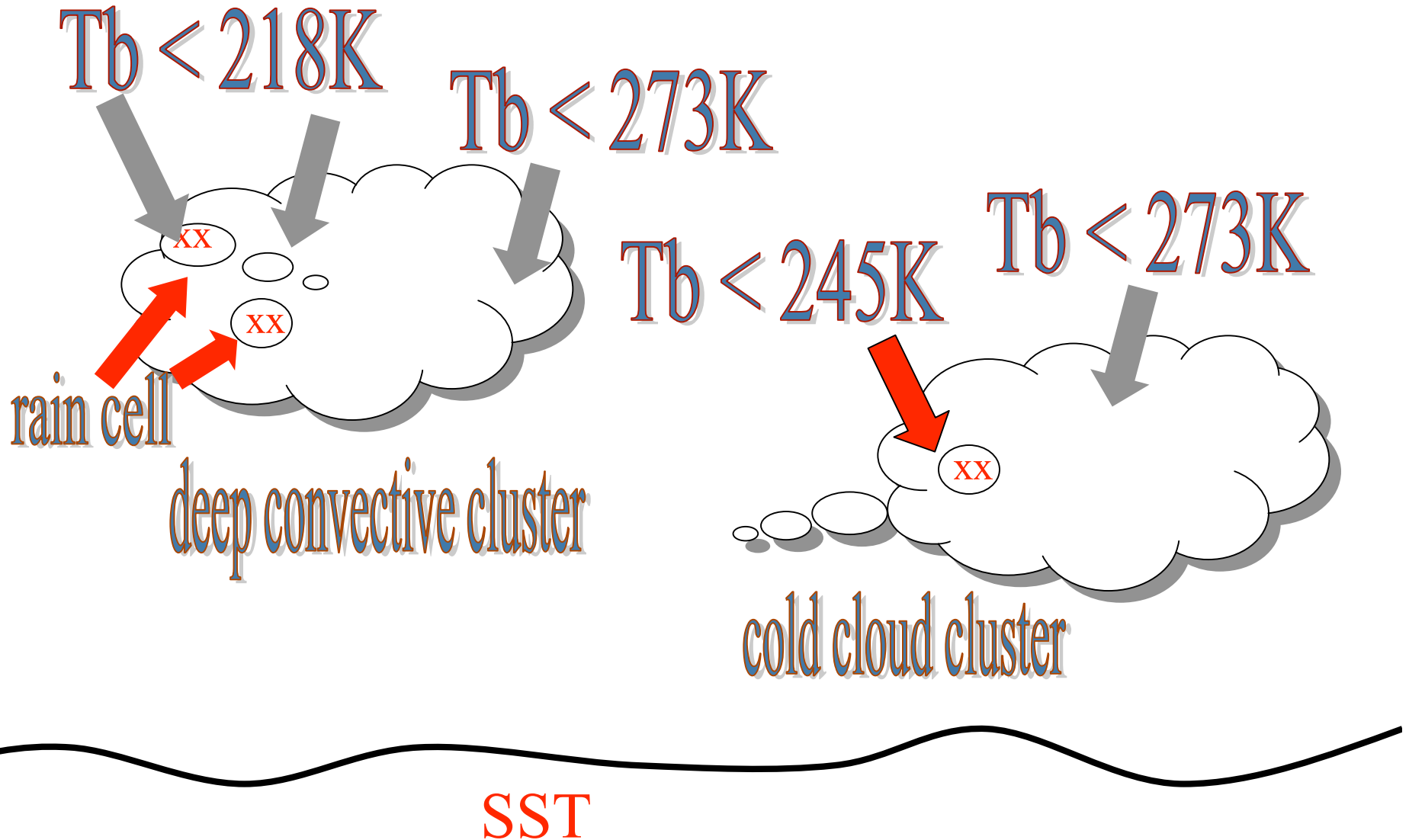
cold cloud clusters: storms + neighboring cold clouds

deep convection: $T_b(11\mu\text{m}) < 218\text{K}$ + rainfall cell

deep convective clusters: cold cloud clusters with DC

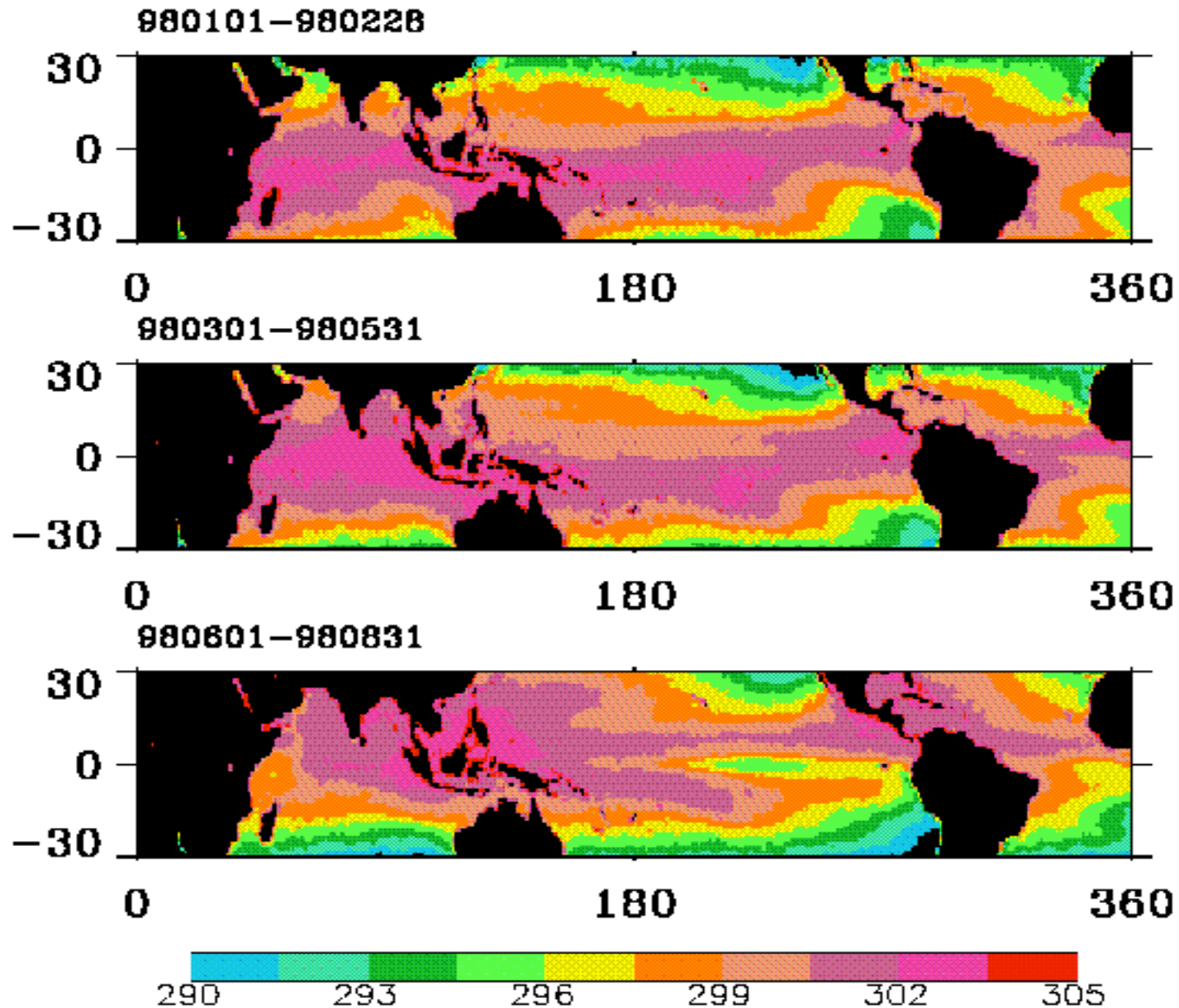


Cloud cluster classification



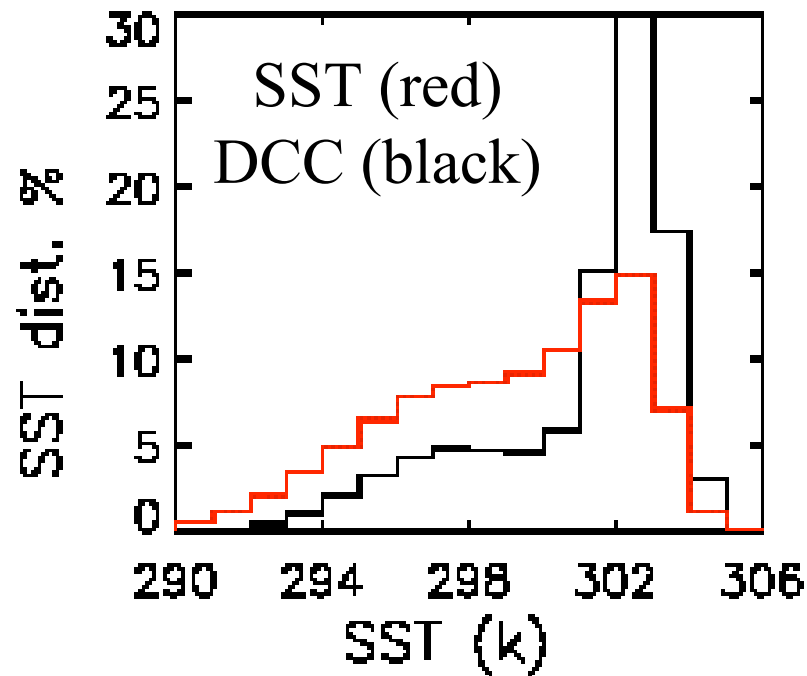


Tropical SST

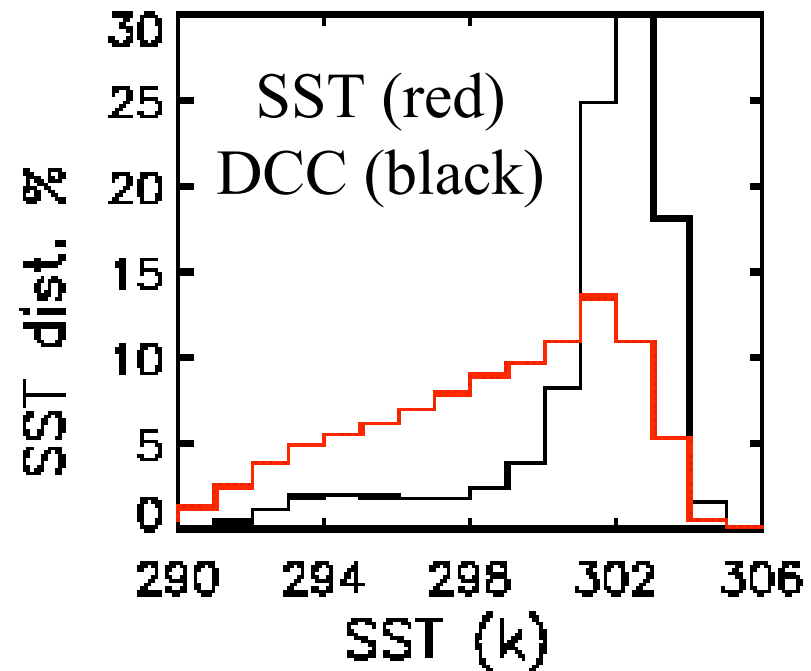




SST and cloud distribution



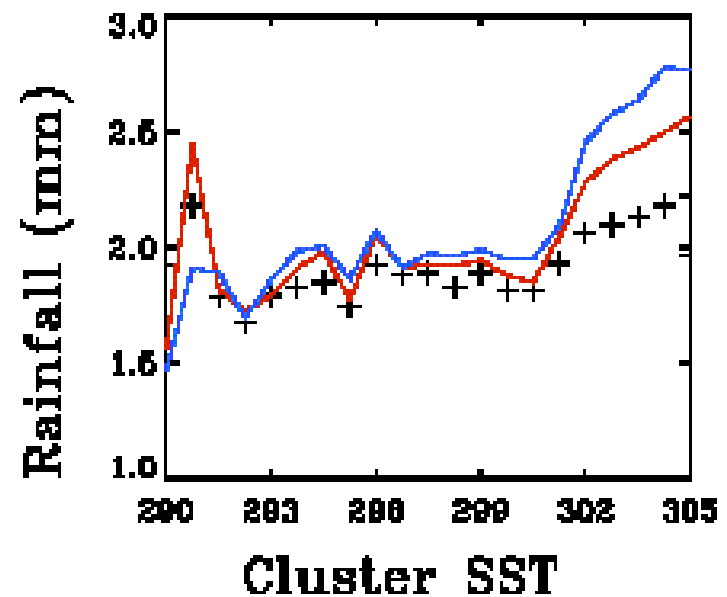
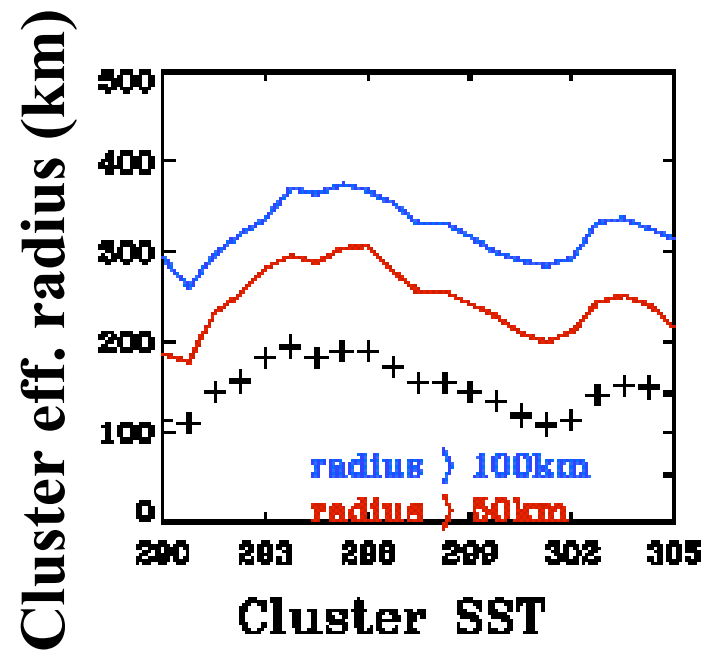
9803 - 9805



9806 - 9808



SST with cluster size

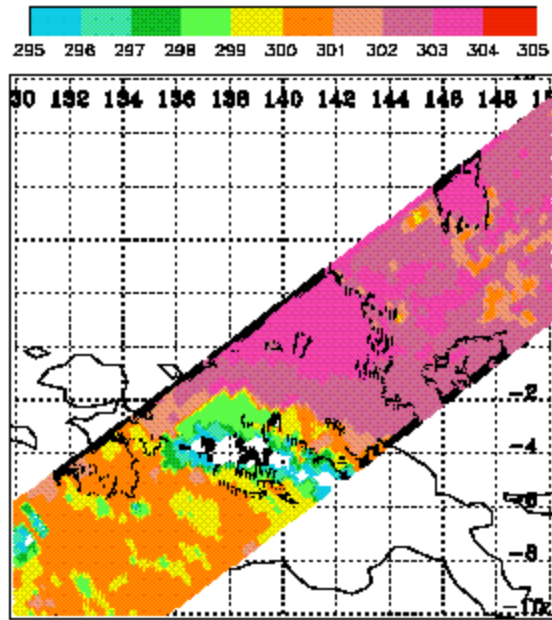




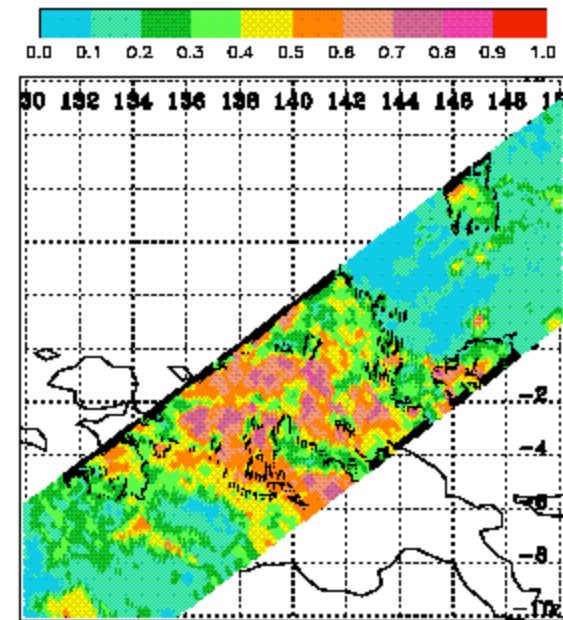
warm SST case (980801)



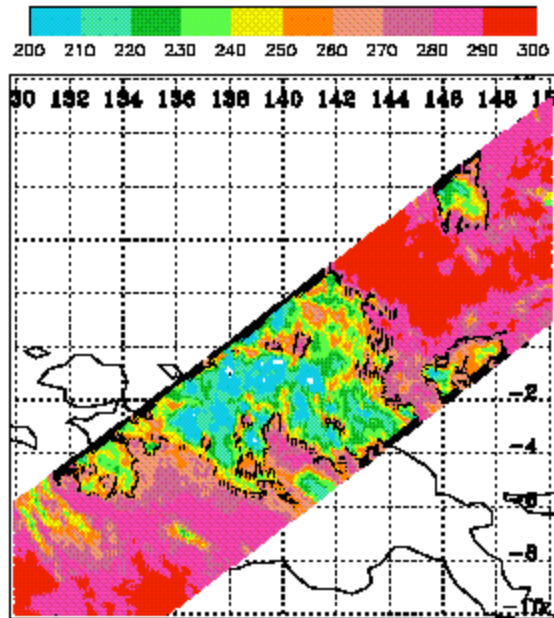
SST (K)



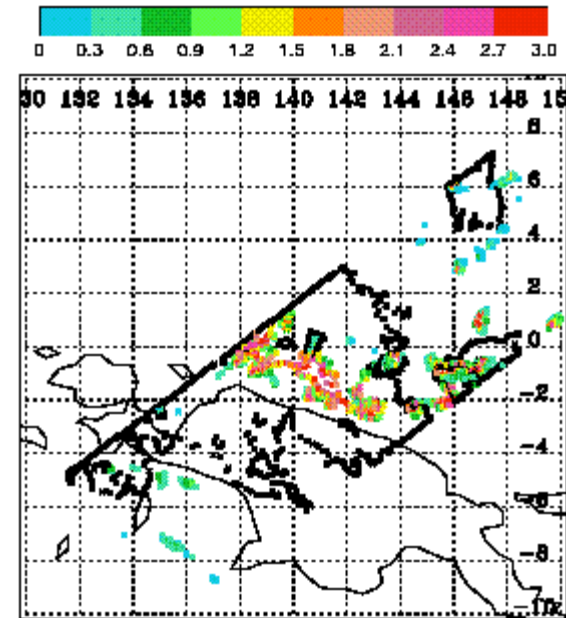
albedo



Brightness temp (K)



Contour & rain (mm)

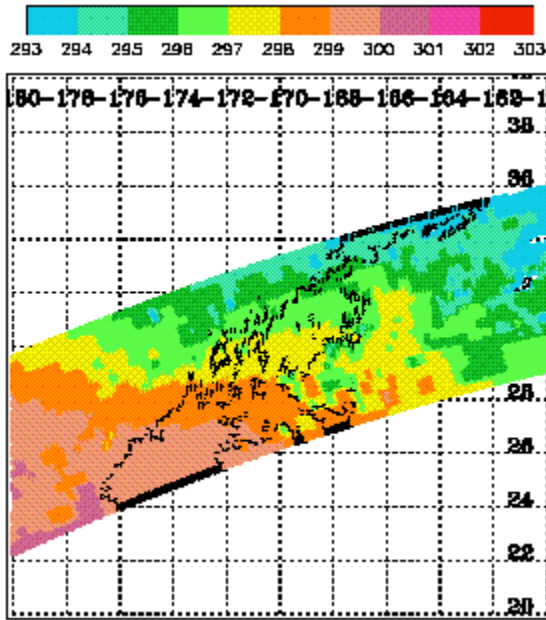




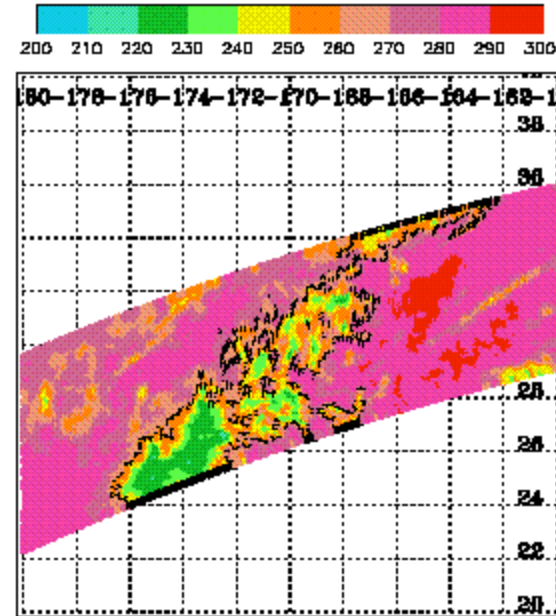
subtropical case (980619)



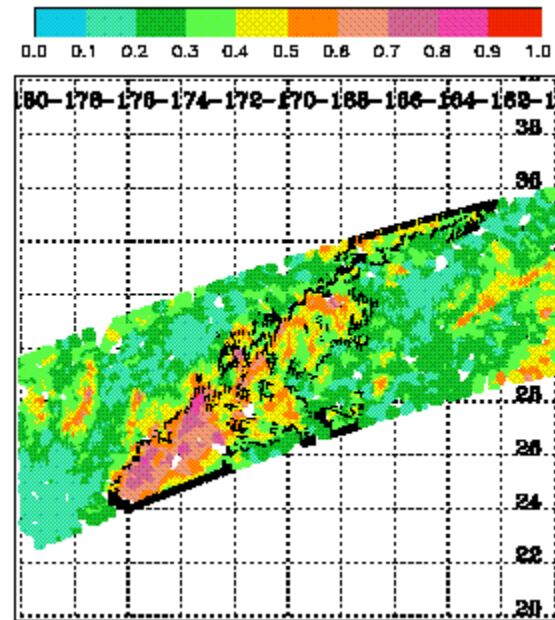
SST (K)



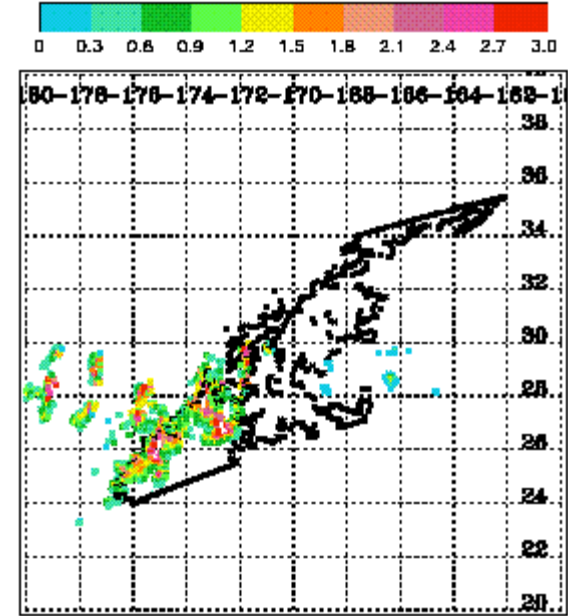
Brightness temp (K)

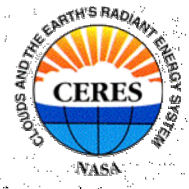


albedo

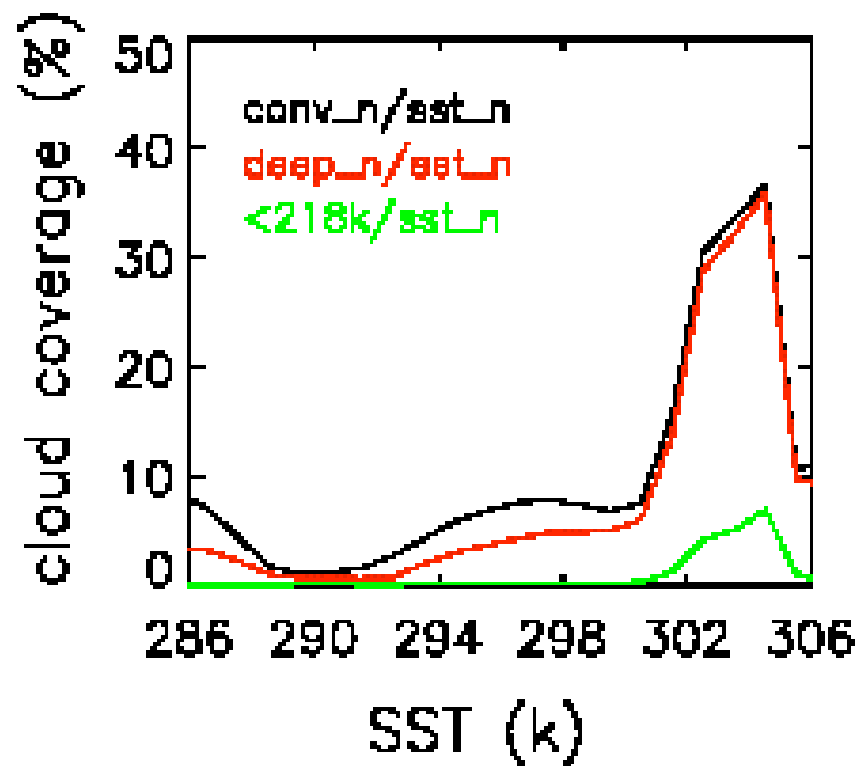
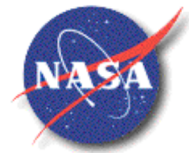


Contour & rain (mm)

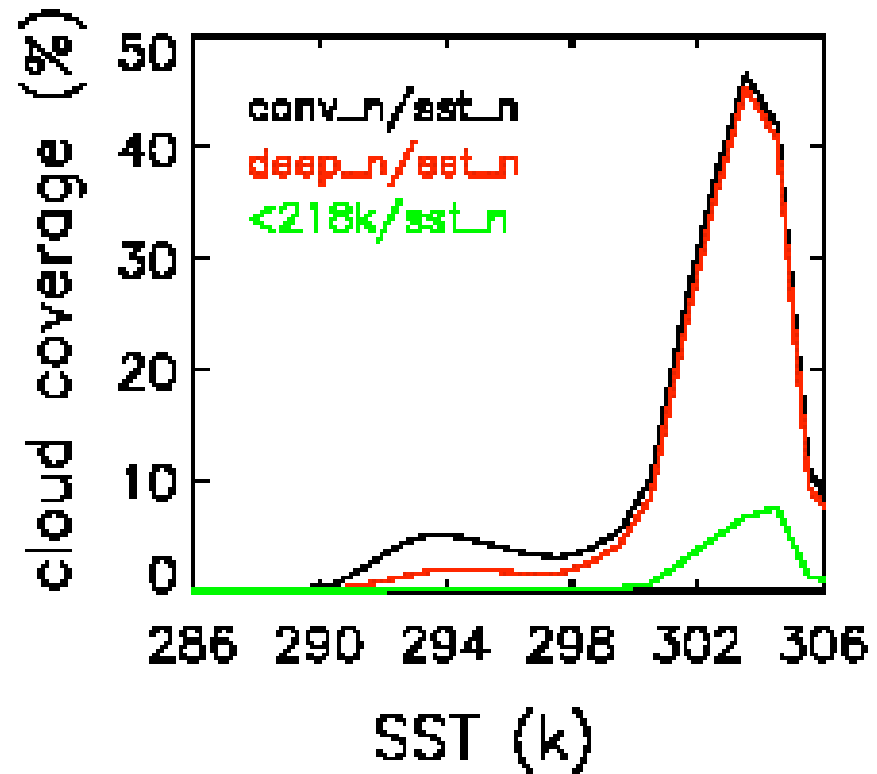




DCC amount vs SST



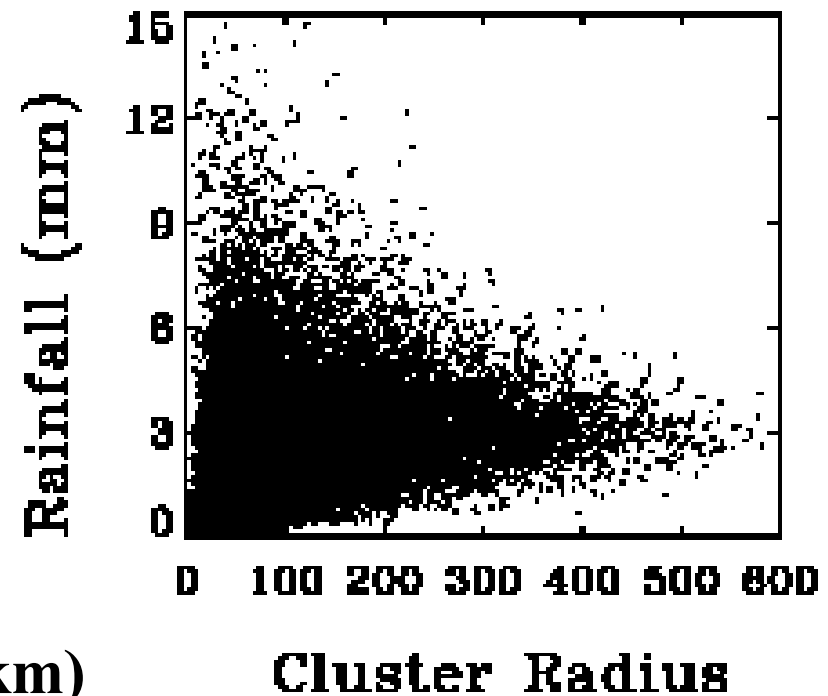
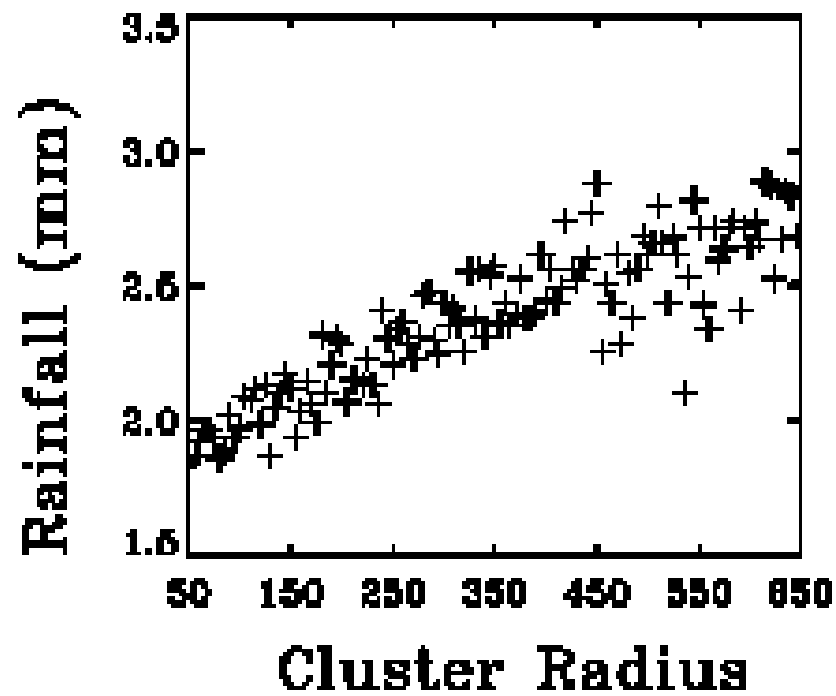
9803 - 9805

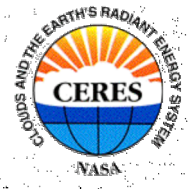


9806 - 9808

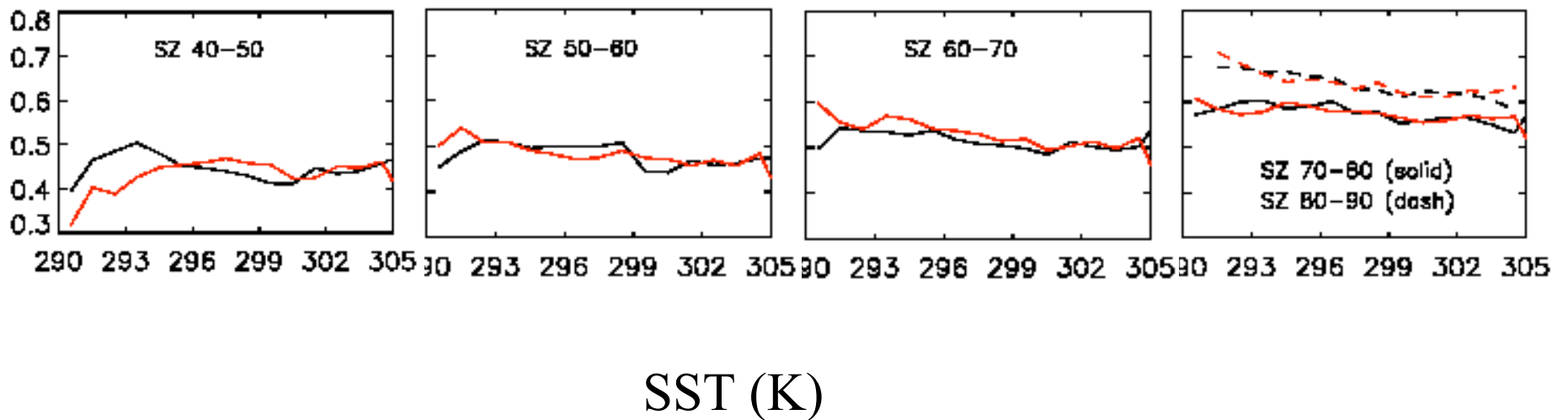
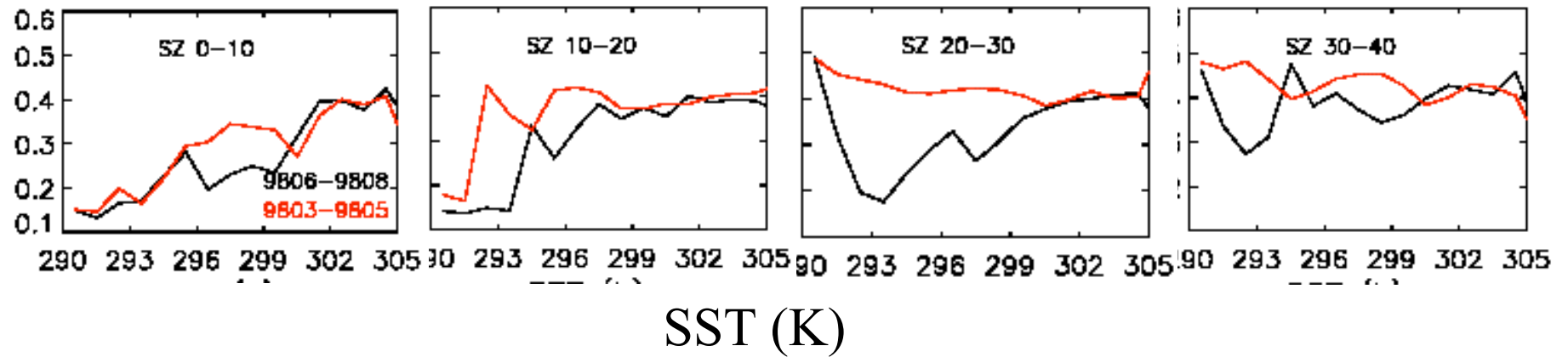


DCC size vs rainfall rate



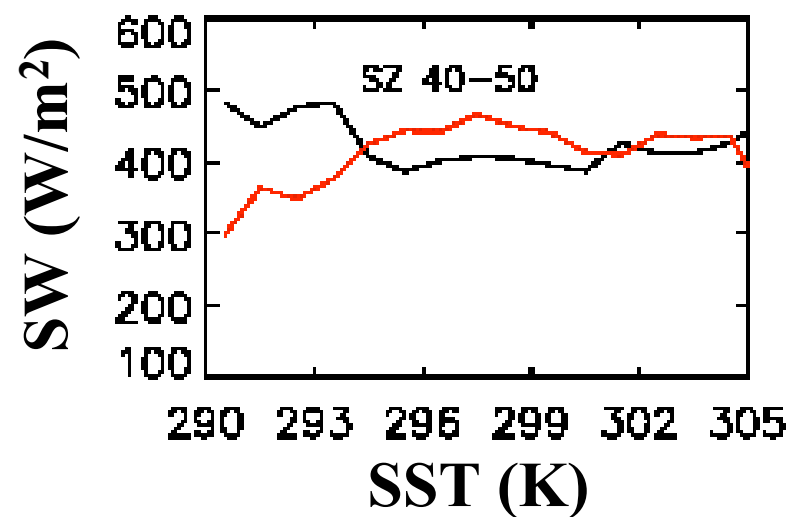
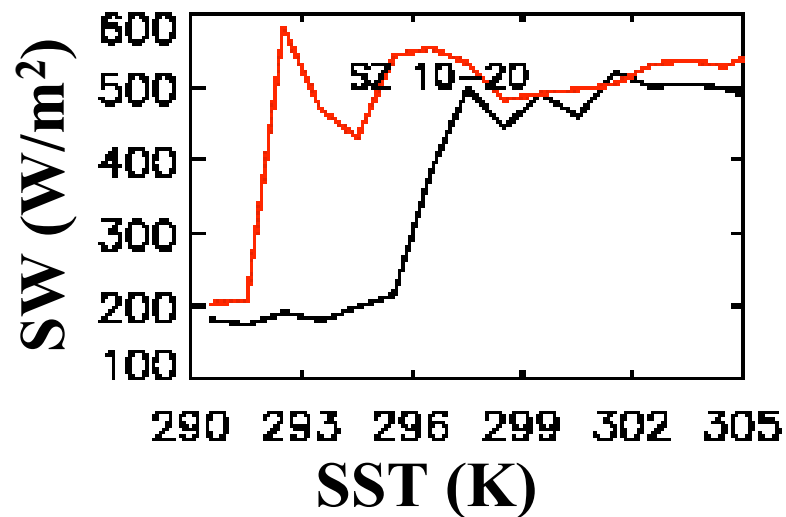
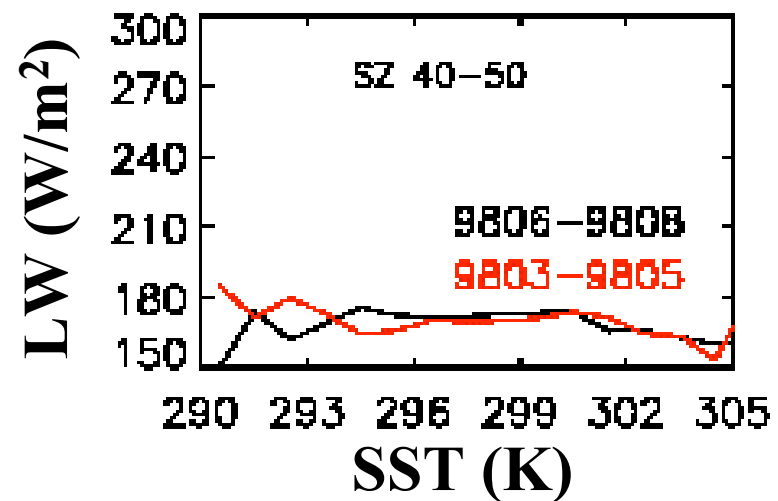
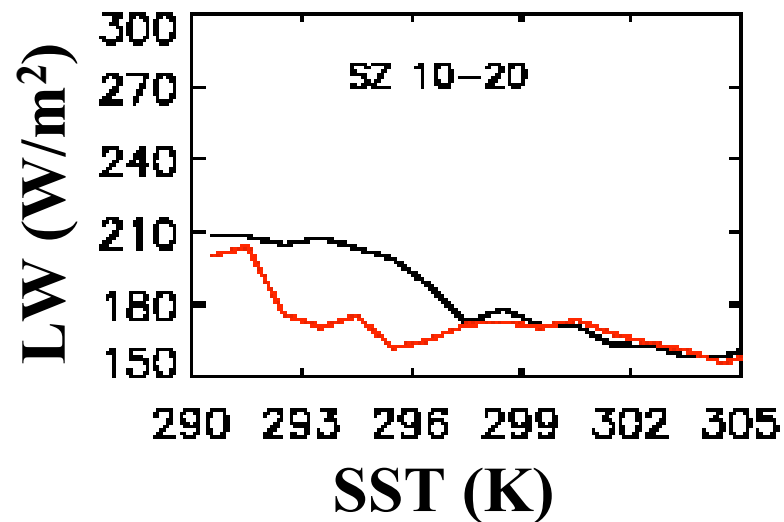


Albedo



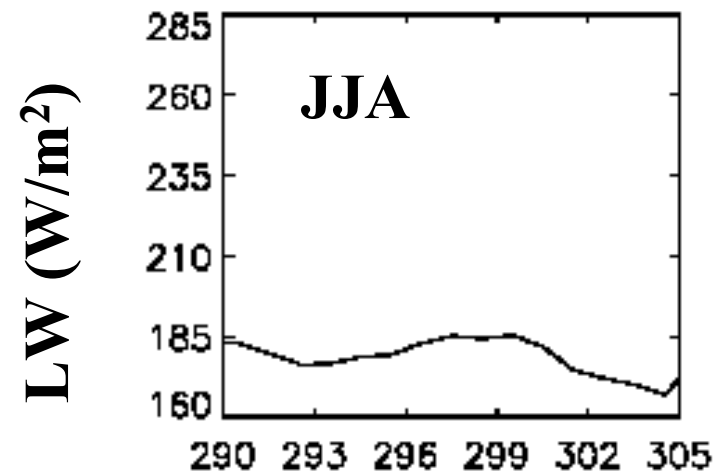
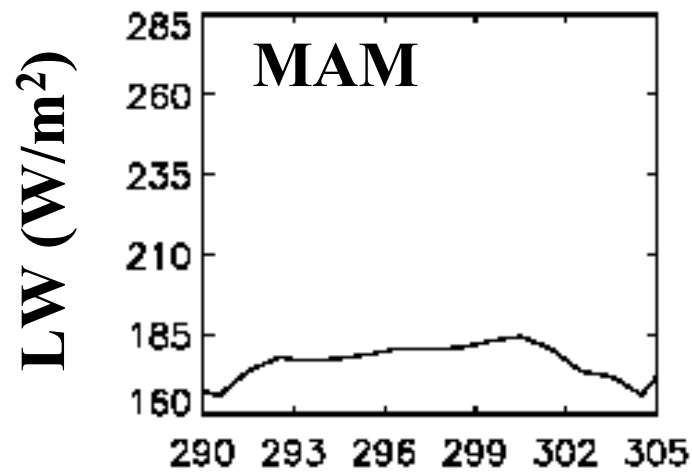
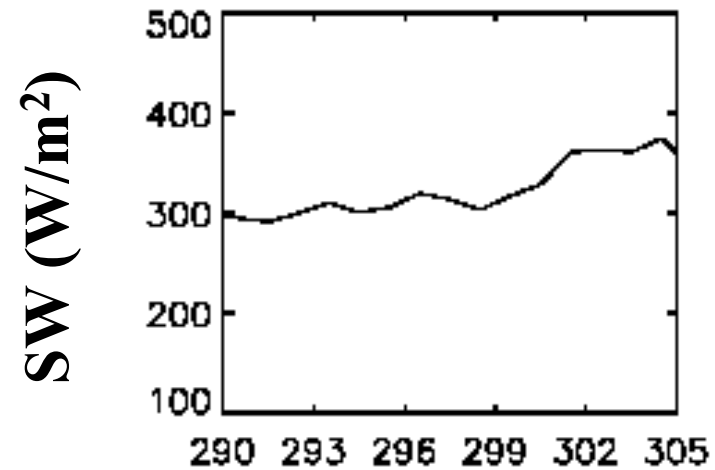
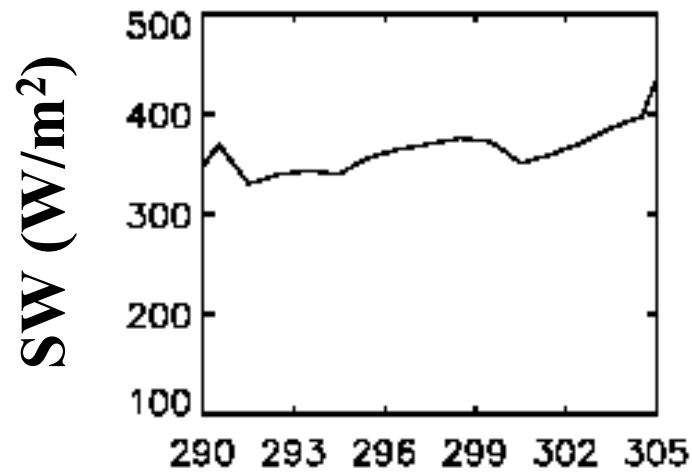


LW and SW





Mean SW and LW



SST (K)

SST (K)



Summary



- TRMM satellite provides major physical properties for the studies of tropical convective clusters. (including rainfall: coverage and rates; clouds: detection, cloud top temperature, radiation, LWP/IWP)
- Generally, the warmer the cloud SST, the heavier the rainfall. And, the stronger the precipitation, the larger the cluster size. The large averaged cluster size in cooler SST areas indicates dynamic regime differences of warmer and cooler SST areas.
- In absolute sense, the cloud coverage and deepness of deep convective clusters increases with tropical SST. Also, the variations of LW with SST are similar for different seasons, which may support fixed anvil temperature hypothesis.
- Since many tropical dynamics is important for the organized systems, more studies on tropical SST gradients, boundary layer moisture divergence, and cluster life cycle are needed for high cloud feedbacks.



Acknowledgements



- Thanks the NASA's support for the tropical deep convection project.
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